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Twisted bilayer and trilayer graphene

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The overlay of graphene monolayers with a relative twist has experimentally led to a plethora of correlated physics: superconductivity, correlated insulating phases, nematicity, integer and fractional Chern insulators, spontaneous flavor and magnetic polarization, orbital ferromagnetism or strange-metal behavior. All these phenomena originate from the strong band structure remodeling due to interlayer tunneling combined with a twist. For the bilayer case, at some "magic"angle around 1°, the spectrum becomes relatively flat, thereby considerably enhancing the relative strength of Coulomb interactions and triggering interaction-dominated phases.

Twisted materials offer a playground for investigating band features at accessible doping. We have shown that the band structure of twisted bilayer graphene exhibits a rapidly evolving orbital magnetic response that alternates between paramagnetic and diamagnetic. We have also identified in the trilayer case a new class of van Hove singularities with non-trivial exponents and a scaling anomaly at a topological Lifshitz transition. For three layers in a staircase configuration where moiré of moiré pattern emerges, we have devised a wavefunction approach that captures the low-energy physics with a non-abelian gauge field.

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